Spawning Characteristics of Gila Chub In Cienega Creek, Arizona

By

Benjamin T. Nelson

December 13, 1993

Introduction:

Gila chub, (*Gila intermedia*) is recognized by the American Fisheries Society as a subspecies of *Gila robusta*, the roundtail chub (Rinne 1976; Robins et al. 1980). Gila chub is a secretive fish, occupying areas of deep water or near cover (Minkley 1973). It inhabits pools and eddies below riffles in streams with terrestrial vegetation and other kinds of cover such as boulders or fallen logs (Minckley 1991). Terrestrial vegetation that creates undercut banks with dense roots growing down into the pool edges provides ideal cover for Gila chub. It is believed that spawning occurs on vegetation or root wads (Minckley 1973). Minckley (1969a in Minckley 1973) reported reproduction for a population at Monkey Springs, Arizona started in spring and continued through summer, autumn, and into late winter. In other populations, reproduction of Gila chub occurs mostly in late spring and into summer (Minckley 1973; Griffith and Tiersch 1989). I attempted to identify the types of cover and substrate used by chub, the duration of spawning and the water temperature during spawning in Cienega Creek, Arizona.

Female Gila chub have been known to achieve lengths of 25 cm, but males rarely exceed 15 cm (Minckley 1991). They are also known to take on intense colors during spawning. Minckley (1973) reported that color changes in male Gila chub are more intense than in other Arizona chubs. The entire ventro-lateral surface becomes fire-red, and the eye yellow to yellow-orange. I also followed the breeding color changes of Gila chub during the spawning season.

Description of the study area:

Cienega Creek (south of interstate 10) is managed by the U.S. Bureau of Land Management. The creek flows through Pima and Santa Cruz counties and is between the Whetstone and Santa Rita mountains. The headwaters of Cienega Creek are on the

Empire-Cienega Resource Conservation Area (RCA) about 52 miles (84 km) southeast of Tucson and just north of the town of Sonoita. The average rainfall is roughly 15 in (38.1 cm) , and the floral communities surrounding the creek are cottonwood/willow galleries, mesquite bosques, sacaton flats, and low rolling grasslands. Cattle and sheep ranching began in the mid-1860's; however, sheep ranching no longer occurs. Management of the riparian area currently utilizes various grazing treatments. The portion of creek, where this study occurs, is grazed but is limited to the winter months.

Cienega Creek is listed as a high priority protection area by the Desert Fishes Recovery Team (Minckley 1991). There are 3 native species of fish, and no known exotic species in the creek. The native species of fish are: 1). Gila topminnow, (*Poeciliopsis occidentalis*) which is on the federal endangered species list, and the state threatened species list 2). Gila chub, (*Gila intermedia*) is listed on the state threatened species list and is currently a candidate for the federal endangered species list 3). longfin dace, (*Agosia chrysogaster*).

Cienega Creek flows perennial through the RCA. The creek as many classifications of habitat due to the various substrates, vegetation communities, and water depths the creek encounters as it flows. The stream itself can be classified as having areas of marsh, pool, glide, runs and riffles. These classifications can then be further broken down into subclassifications (i.e. run-riffle type) depending on the microhabitat. The segment at which this study occurs is dominated by pools, glides and runs, with marsh not being to common. The subclassifications of this study area consist of having slow moving gliding-pools, and other areas where runs enter into deep pools. The stream mainly flows in a single channel and rarely forms a braided channel. Stream depth can range from a few centimeters in the shallow riffles to up to 2 meters in the deepest pools. The yearly discharge has a cumulative average from 0.6 cfs in June to 2.6 cfs in February (flow station CC-1, BLM data). Water clarity fluctuates greatly with weather conditions and cattle use. After a rain, visibility is limited to a few centimeters and the water has a

reddish/brown color. The sediment will often settle out within 1 day and the bottom of the deepest pools can be seen.

Water clarity was an important factor in gathering observational data during the experiment. On several occasions observational data could not be collected due to turbidity. Turbidity was often elevated due to rain, as Santa Cruz as well as Pima county experienced unusually high amounts of rainfall during the time of this study. On April 10, observations were cut short due to a herd of cows (>30) that had crossed the creek approximately 150 m upstream of the study site. Turbidity also had effects on the collection of fish. On April 10, the method of fish collection was seining and angling, after the cattle crossed, fish collection was impossible and did not happen. The reason as to why fish collection ceased is not understood. It might have made visibility of the bait difficult, or the shock of suddenly turbid water could have altered the feeding behavior of the fish.

Methods and Materials:

Two sampling stations were established on Cienega Creek. Station 1 was used for behavioral observation and station 2 was used to collect fish for observing breeding colors. Station 1 was a 0.7 m deep pool, that had the steady flow of a glide (subclassification gliding-pool), 4.5 m long and a maximum width of 1.1 m. The substrate was gravel mixed with occasional large stones. This glide-pool appeared to have a faster flow rate than station 2 and opened into a large shallow pool lined with cattail (*Typha domingensis*). The banks of station 1 were densely lined with deergrass (*Muhlenbergia rigens*) and sacaton (*Alkali sacaton*) the roots of which formed dense mats below the water surface.

Station 2 was considerably larger than station 1. Above station 2 was a very narrow run with cobble/rubble for substrate. The mouth of station 2 was a pool 2.4 m deep, 2.7 m across, and 3.9 m long. This pool then opened into a wide slow moving glide

with an average depth of 0.6 m. The upstream pool contained large rocks, undercut banks with sacaton and deergrass roots, and was shaded by a willow (*Salix gooddingii*). The downstream glide had deep undercut banks with root wads and was densely lined with deergrass, sacaton and horsetail (*Equisetum laevigatum*).

Several methods of fish capture were used in station 2, these included hook and line, seining , and electrofishing. All three methods provided fish, however electrofishing was by far the best method. Electrofishing gear was set at 75 pulse/sec, 1 amp and 175 volts. Seining did not yield an adequate sample of fish sizes because large fish were able to escape into the root wads. Hook and line yielded an interesting observation; Gila chub consistently hit the sinker instead of the bait (several baits were tried). Electrofishing always yielded a large sample with a broad range of fish sizes. Gila chub spawning periodicity was determined by the presence of breeding colors, tubercles, behavioral displays and ability to express eggs or milt.

Upon collection of individuals total length (TL) and standard length (SL) as well as breeding color intensity were recorded. Breeding color intensities were categorized into four classifications: 1) intense color 2) moderate color 3) slight color and 4) no color (Figure 1).

Results:

Intensely colored Gila chub were collected on several occasions. These fish ranged in size from 80 to 235 mm (TL), and 65 to 206 mm (SL) (Table 1). The average size of fish that displayed intense colors was 163 mm (TL), and 134 mm (SL). Intensely colored fish were not collected on the first two sample dates (Feb. 2 and March 11) when water temperatures were 13^{O}C and 17^{O}C, respectively. Intensely colored fish were collected when the water temperature was 20.5^{O}C on March 21 (Figures 2 and 3). Of the total fish sampled during the study 23.8 % were classified as intensly colored.

Moderately colored fish ranged in size from 74 to 120 mm (TL), and 60 to 110 mm (SL), with an average size of 93 mm (TL), and 79 mm (SL) (Table 1). Moderately colored fish were collected on all the sampling dates and were present in temperatures of 13°C to 24°C (Figures 2 and 3). This classification accounted for 19.6% of the total fish sampled.

Slightly colored fish ranged from 69 to 185 mm (TL), and 61 to 155 mm (SL) with an average of 95 mm (TL), and 80 mm (SL). These fish were collected on all sampling dates and accounted for 20.3% of the total fish sampled.

Fish showing no color ranged from 42 to 105 mm (TL), and 34 to 84 mm (SL) with an average of 60 mm (SL), and 73 mm (TL). Of all fish sampled, 36.4% showed no breeding color and fish without color were present on all sampling dates.

Observations of Gila chub were often difficult due to the turbidity of water and because these fish move back and forth among root wads and other cover. However on March 21, three large (roughly 120 mm TL) fish were observed chasing each other in a formation. This formation had a lead fish with the other two on each side. This behavior could indicate male fish pursuing a female. The observations of the two pursuing fish revealed them butting their nape area against the lower abdominal region of the lead fish. This action might be interpreted as two male fish physically testing the female for receptivity or ripeness. This activity took place at the bottom of station 2, in the middle of the pool away from the root wads. On other occasions, smaller fish were observed following each other although this behavior only lasted a few seconds. It is unclear if this behavior indicated fish preparing to spawn or simply fish chasing each other.

None of the fish collected throughout the study exhibited strong tubercle morphology. There were tiny speckled colorations on the nape, but these were not raised tubercles. However, small tubercles were present on the first two rays of the pectoral fins. These tubercles were on fish of intense and moderate coloration, but did not occur on every individual displaying these colorations. I was unable to extract eggs or milt during

the study. Even the very large intensely colored fish failed to produce any indication of reproductive gametes.

Table 1: Size distributions (in mm) of individuals displaying breeding colors in Cienege Creek, 1993.

classification	(SL) range	[average]	(TL) range	[average]
intense	65-206	[134]	80-235	[163]
moderate	60-110	[79]	74-120	[93]
slight	61-155	[80]	69-185	[95]
no color	34-84	[60]	42-105	[73]

Discussion:

Griffith and Tiersch (1989) upon dissection of Gila chub, reported ripe males and females with lengths of 90 to 95 mm (did not indicate SL or TL). I collected large individuals (>95 mm SL) with moderate and intense color, swollen papilla, and swollen abdominal areas. However, upon pressing the abdominal region no gametes were ever extruded. Therefore, it is unknown if these fish, even the intensely colored individuals were ripe with gametes. My data on size and breeding coloration suggest that individuals > 75 to 80 mm (TL) could participate in spawning. Further investigation needs to be conducted to identify which color classifications represent spawning fish.

Color intensities did grow progressively stronger as water temperatures warmed. On several occasions (April 22 and June 19) intensely colored individuals made up the majority of the fish sampled. These dates had water temperatures of 23^{o}C and 24^{o}C, respectively. The daily temperature fluctuation for these dates is unknown, and the rate at which individuals change colors is also unknown. By the time water temperature reached 20^{o}C (March 21) individuals are capable of intense breeding coloration. The record of breeding colors suggests that spawning begins in mid-March and lasts beyond June 19.

Spawning is largely dependent on temperature, so in hot seasons spawning could begin before March 21. In future studies certain large individual fish could be marked and their color monitored over the spawning season.

Spawning periodicity of Gila chub is believed to be sporadic over the spawning season (Minckley 1991). On several sampling dates, some fish large enough to be mature had intense coloration and others had no breeding coloration. This indicated to me that during the spawning season only certain individuals will display intense color at certain times. As to the factors that determine which individuals display breeding colors and which do not needs further investigation.

Minckley (1973) reported that during spawning large females were followed by a large number of smaller males, over beds of submerged vegetation. I never observed large numbers of fish following each other. I saw three individuals following each other but this behavior was in deep water away from submerged vegetation. Undercut banks played a role in preventing observation of Gila chub. Gila chub often move back and forth from the open water column to undercut banks. This behavior indicates how important cover is to the overall life history of these fish.

Gila chub were often observed to nose the benthic region of the stream. This behavior probably was not related to any form of redd building. The largest Gila chub are often found in deep pools and eddies below areas of swift currents (Minckley 1991). The substrate of these pools is often fine sand, silt and clays. Building and maintaining a redd in a constantly changing benthic region would require lots of energy. I suspect that deep pools with vegetation are important sites for spawning. However, I never witnessed any spawning or associated behavior near submerged vegetation.

Literature Cited:

Griffith, J. S., and Tiersch T. R. 1989. Ecology of fishes in Redfield Canyon, Arizona, with emphasis on *Gila robusta intermedia*. The Southwestern Naturalist 34:131-135.

Minckley, W. L. 1973. Fishes of Arizona. Arizona Game and Fish Dept., Phoenix, AZ 293pp.

_____. 1991. Native fishes of arid lands: a dwindling resource of the desert southwest. General Technical Report RM-206, USDA Forest Service. Phoenix, AZ. 42pp.

Rinne, J. N. 1976. Cyprinid fishes of the genus *Gila* from the lower Colorado River basin. Wasmann J. Biol. 34:65-107.

Robins, C. R., ET AL. 1980. A list of common and scientific names of fishes from the United States and Canada. Fourth ed. Spec. Publ., American Fisheries Society, Bethesda, Maryland.

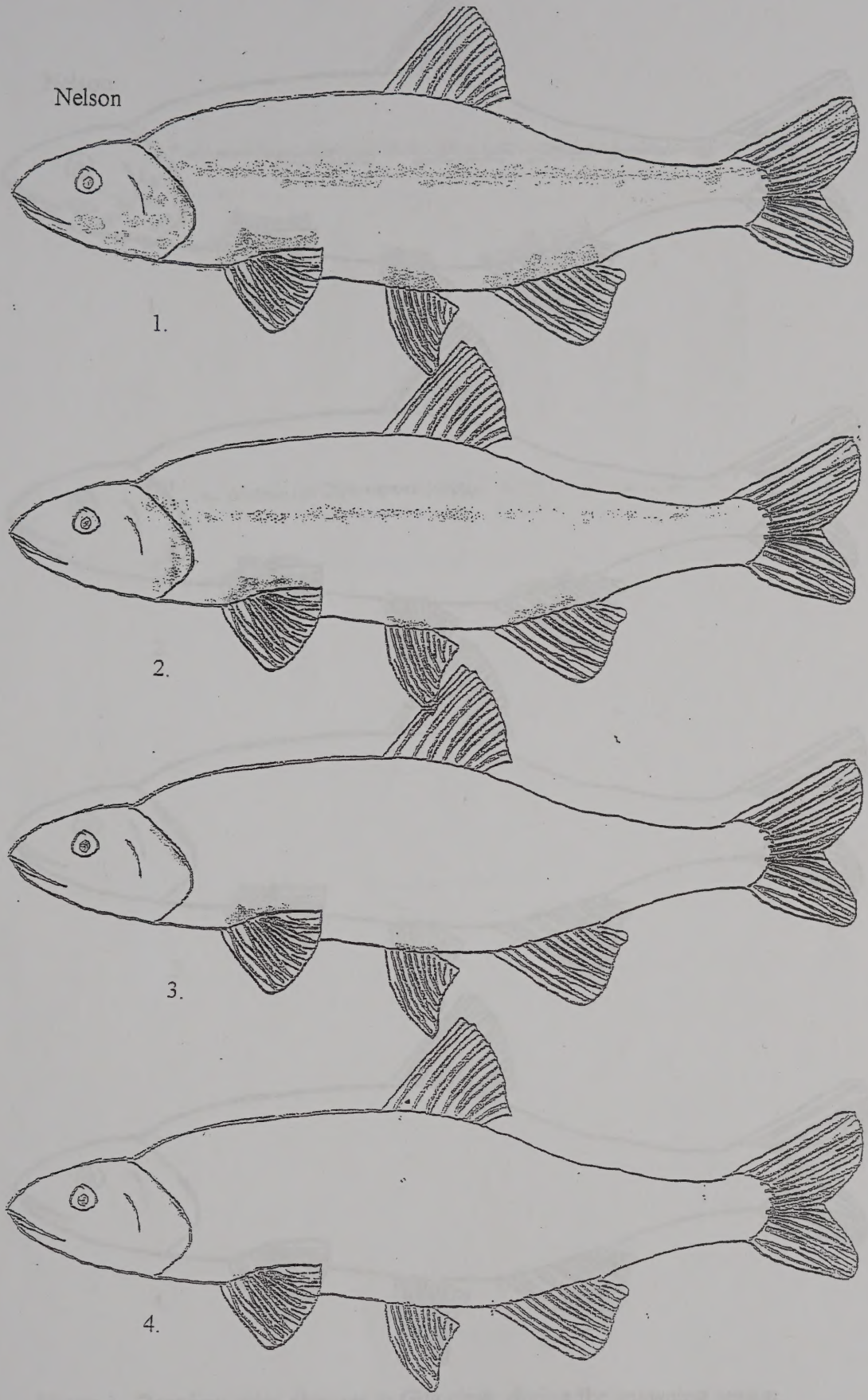
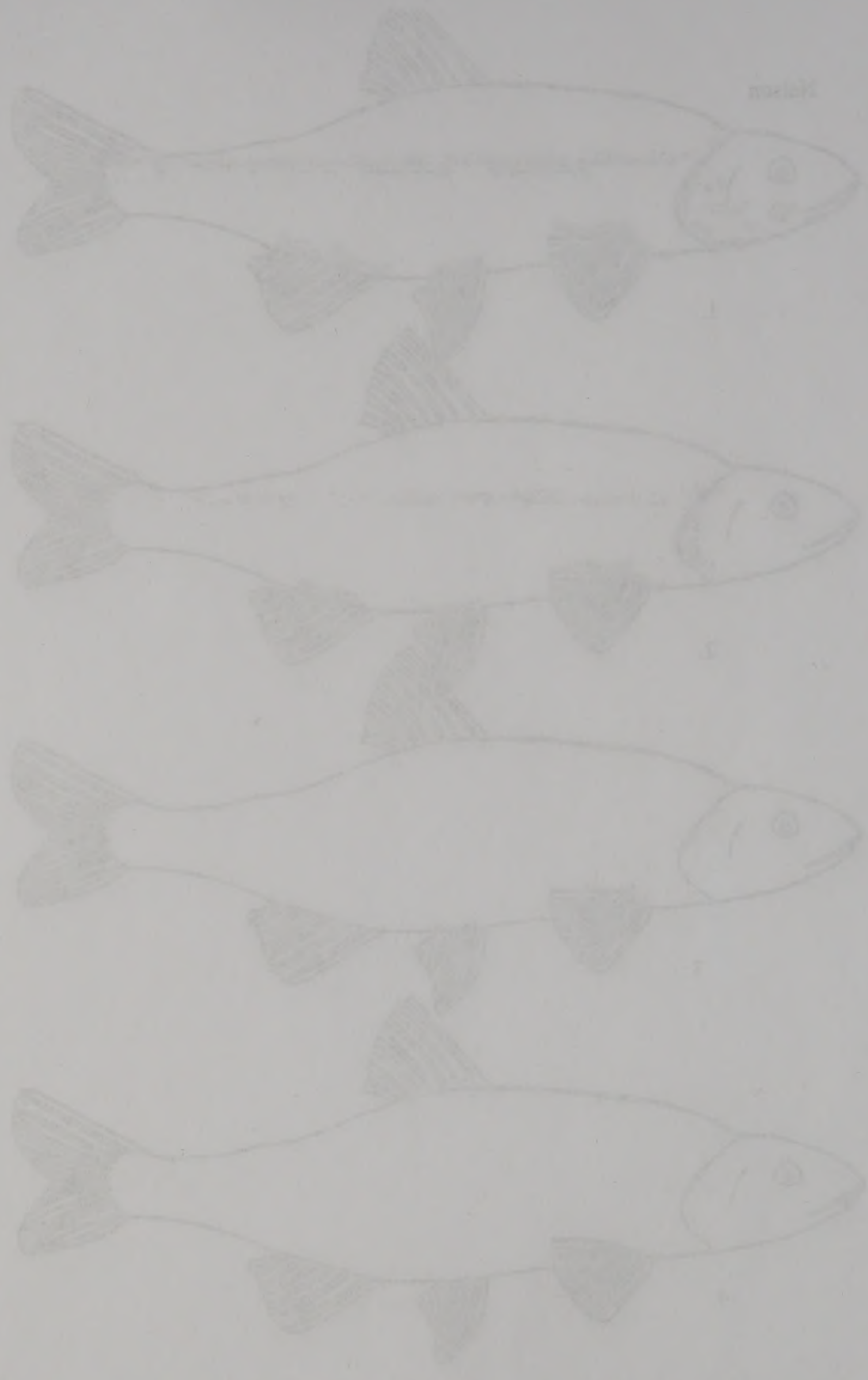


Figure 1: Breeding color changes in Gila chub, during the spawning season.
1) Intense, 2) Moderate, 3) Slight, 4) No Color



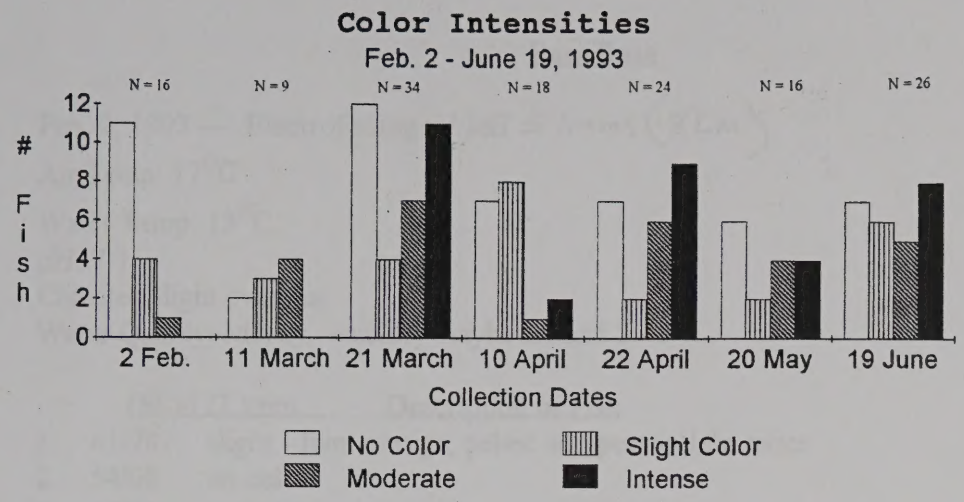


Figure 2: Gila chub individuals displaying the various color intensities on collection dates.

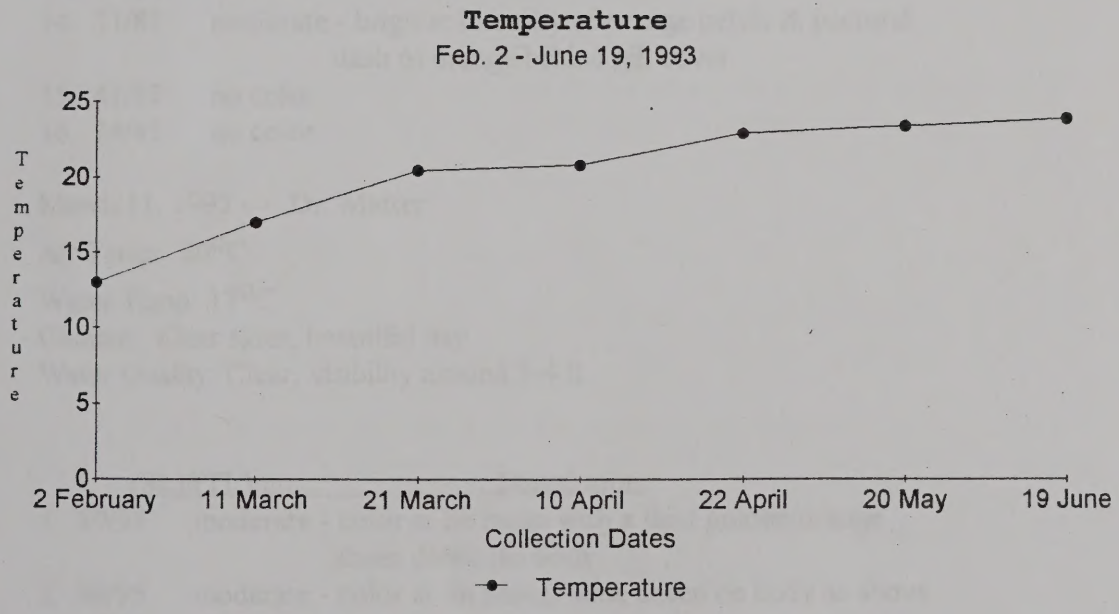
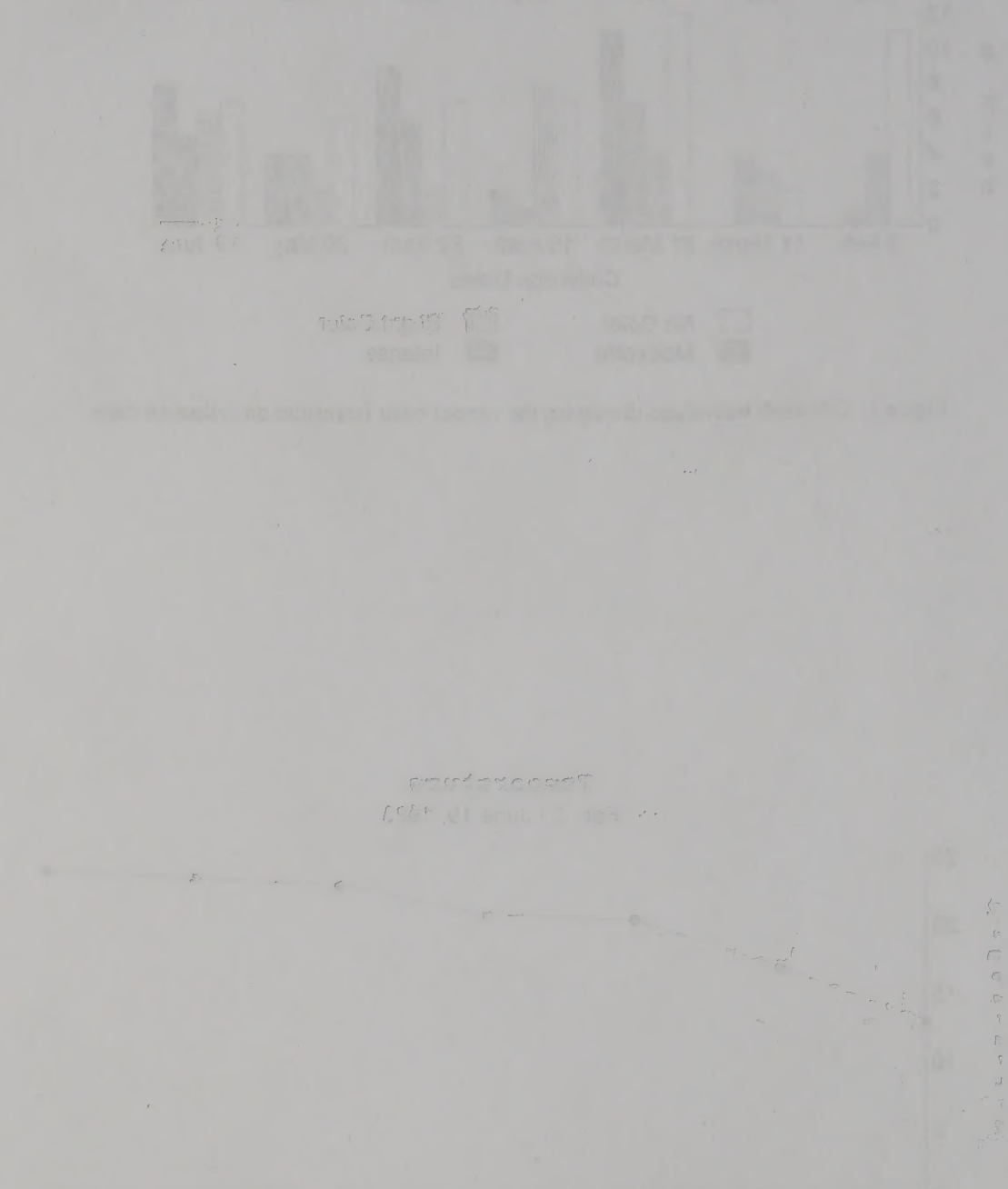


Figure 3: Water temperatures recorded on collection dates.



Raw Data

Feb. 2, 1993 --- Electrofishing w/ Jeff Simms (BLM)

Air Temp: 17°C

Water Temp: 13°C
pH: 7.7
Climate: Slight overcast
Water Quality: Murky, visibility maybe around 2 - 3 ft

	(SL)/(TL)mm	Description of Fish
1.	61/78	slight - faint orange, pelvic and pectoral fin bases
2.	54/68	no color
3.	46/59	no color
4.	77/95	slight - faint orange pelvic & pectoral fin bases
5.	40/50	no color
6.	68/82	no color
7.	79/96	no color
8.	42/53	no color
9.	69/85	no color
10.	54/69	no color
11.	90/109	slight - faint orange pelvic & pectoral fin bases
12.	74/90	slight - small patches of bright orange pelvic & pectoral slight orange on operculum
13.	60/75	no color
14.	71/87	moderate - brighter intensity of orange pelvic & pectoral dash of orange behind gill cover
15.	41/52	no color
16.	34/45	no color

March 11, 1993 --- Dr. Matter

Air Temp: 20°C

Water Temp: 17°C
Climate: Clear skies, beautiful day
Water Quality: Clear, visibility around 3-4 ft

	(SL)/(TL)mm	Description
1.	89/95	moderate - color at fin bases with a faint golden/orange sheen down the body
2.	89/95	moderate - color at fin bases, same sheen on body as above
3.	64/69	slight
4.	75/81	no color
5.	68/72	slight
6.	73/79	no color

7. 110/120 moderate - orange at pectoral & pelvic fin bases, sheen not as intense
8. 91/98 slight
9. 73/77 moderate - orange at pectoral & pelvic fin bases

March 21, 1993

Air Temp: 27°C

Water Temp: 20°C
Climate: Clear skies at beginning of day, overcast and rain in late afternoon
Water Quality: Turbid, visibility not as good as before, .5-1.5 ft

	(SL)/(TL)	Description
1.	64/77	no color
2.	68/86	slight
3.	65/80	intense - orange color at fin bases & corner of mouth
4.	81/100	intense - color at anal., pectoral, corner of mouth, operculum
5.	87/106	intense - same as above but color not as bright
6.	65/79	no color
7.	67/84	moderate - lightly colored at fin bases, operculum
8.	50/63	no color
9.	60/74	moderate - lightly colored at fin bases, operculum
10.	53/67	no color
11.	56/70	moderate - lightly colored at fin bases, operculum
12.	59/71	no color
13.	34/42	no color

March 21 (continued) ****deep pool just on the other side of the road, huge boulders at the waters edge, shaded by a young willow, pool is ~ 6ft deep***

Water Temp: 21°C

	(SL)/(TL)	Description
14.	70/87	slight
15.	132/162	intense - color over mouth and cheek area, at all fin bases, very bright orange intensity *****took pictures, slides of this fish in aquarium**********
16.	151/183	intense - color intensity same as above fish; genital papillae swollen
17.	146/179	intense - color intensity same as above fish; color is also down on the pectoral, pelvic, anal. fins****pictures, slides******
18.	85/115	moderate - lightly colored at fin bases, operculum
19.	62/76	no color
20.	93/104	moderate - fin bases, operculum
21.	56/71	no color
22.	135/167	intense - color very bright, mouth, cheek, operculum, swollen papillae

23. 135/165 intense - same as above fish; spots of bright orange color from cheek area extended down under the mouth
24. 84/104 moderate
25. 67/84 slight
26. 53/65 no color
27. 74/90 moderate - color at fin bases, pectoral, pelvic, anal
28. 84/102 slight
29. 54/68 no color
30. 66/81 no color
31. 70/87 no color
32. 206/243 intense - color on operculum, cheek, pectoral, pelvic,anal; swollen papillae
33. 122/152 intense - same as above fish
34. 198/235 intense - same as above fish

April 10, 1993

Air Temp: 30°C

Water Temp: 20.9°C
Seining w/ George
Climate: Very clear skies, also very hot
Water Quality: Visibility low in beginning of day, herd of cows crossed stream visibility zero

	(SL)/(TL)	Description
1.	59/75	no color
2.	47/60	no color
3.	64/80	slight
4.	65/83	no color
5.	71/87	moderate
6.	42/53	no color
7.	61/78	slight
8.	64/69	slight
9.	91/98	slight
10.	54/68	no color
11.	44/57	no color
12.	64/69	slight

Angling, on the same day

13. 155/187 intense - color around fin bases very bright, anal, pelvic, pectoral
14. 92/76 slight
15. 70/85 slight
16. 81/100 intense - color at fin bases, anal, pectoral, pelvic, operculum
17. 75/91 no color
18. 84/102 slight

April 22, 1993

Air Temp: 32°C

Water Temp: 23°C
Electrofishing w/ Dr. Matter, George and Tom
Climate: Occasional clouds by end off the day very overcast and ready to storm
Water Quality: Very clear, visibility to the bottom of the deep pools

	(SL)/(TL)	Description
1.	97/116	intense - color on cheek, at fin bases pectoral, pelvic, tubercles extremely slight on nape, and first two rays of pectoral fin
2.	174/210	intense - color at fin bases and on cheek, no trace of tubercles
3.	155/185	slight
4.	81/106	intense - color at fin bases, slightly on cheek area
5.	64/80	slight
6.	47/59	no color
7.	97/116	intense - color at all fin bases, yellow/orange sheen along lateral line
8.	75/91	no color
9.	75/90	moderate
10.	84/105	no color
11.	56/70	moderate
12.	122/152	intense - color at fin bases pectoral, anal, pelvic
13.	65/80	intense - color at base of fins pectoral, anal, pelvic
14.	45/57	no color
15.	122/152	intense - color at fin bases, anal, pectoral, pelvic, also on operculum, slightly colored on cheek area
16.	70/87	no color
17.	67/84	moderate
18.	53/67	no color
19.	110/120	moderate
20.	146/179	intense - color at fin bases, anal pectoral pelvic, color on cheek and throat area
21.	106/81	intense - color at base of fins, yellow/orange sheen lateral line
22.	56/70	moderate
23.	71/87	moderate
24.	65/83	no color

May 20, 1993

Air Temp: 33°C

Water Temp: 23.5°C
Climate: Occasional clouds, incredibly hot

Water Quality: Hard to see the bottom of pools, due to reflection of sun, even with polarized glasses

	(SL)/(TL)	Description
1.	56/71	no color
2.	97/116	intense - color at fin bases, pectoral,anal, pelvic
3.	70/75	no color
4.	91/98	slight
5.	85/115	moderate
6.	52/62	no color
7.	64/77	no color
8.	75/90	moderate
9.	151/183	intense - color at fin bases, sheen along lateral line, color on cheek area
10.	84/102	slight
11.	135/167	intense - color at base of fins, pectoral, anal, pelvic
12.	70/87	no color
13.	122/152	intense - color at base of fins, sheen along lateral line
14.	84/104	moderate
15.	89/95	moderate
16.	54/68	no color

June 19, 1993

Air Temp: 35^{o}C

Water Temp: 24^{o}C

Climate: Occasional thunderhead, it rained a couple of days ago

Water Quality: Very turbid water, looks reddish/brown, due to runoff of rain

	(SL)/(TL)	Description
1.	77/93	no color
2.	65/80	intense - color at base of fins, pectoral, pelvic, anal
3.	84/104	moderate
4.	61/78	slight
5.	64/69	slight
6.	79/96	no color
7.	135/165	intense - sheen over lateral line, color at bases of fins, color also on cheek area
8.	110/120	moderate
9.	56/70	moderate
10.	84/102	slight
11.	66/81	no color
12.	132/162	intense - color at base of fins, pectoral, anal, pelvic
13.	97/116	intense - same as above fish
14.	62/76	no color

15. 60/74 moderate
16. 70/87 no color
17. 64/80 slight
18. 81/100 intense - sheen along lateral line, color at fin bases
19. 146/179 intense - same as above fish
20. 73/77 moderate
21. 135/167 intense - color at base of fins, pectoral, anal, pelvic
22. 91/98 slight
23. 90/109 slight
24. 60/75 no color
25. 174/210 intense - color at fin bases, sheen over lateral line
26. 59/71 no color